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Early development of the neocortex in human foetuses aged 9 weeks

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A study was made of human embryos at the end of 8 weeks and foetuses aged 9 weeks. It was shown that at the beginning of the foetal period the cortical plate, which is the primordium of the neocortex, covers the whole surface of the cerebral hemisphere. The plate consists of 8–12 rows of densely packed cells. Below the cortical plate is the subplate.

Key words: human neuroembryology, cortical plate, neocortex

INTRODUCTION

The ontogenesis of the neocortex has fascinated many scientists [8]. It is also of great clinical interest, because abnormalities in the cortical layers as well as abnormalities of the neurotransmitter system and neuronal connections may result in many disorders.

Most studies on the development of the human neocortex have been performed either in the embryonic period or in the 2nd and 3rd trimesters of pregnancy [1, 3, 4, 6, 7].

The aim of the present study is a description of the cortical plate in human foetuses aged 9 weeks.

MATERIAL AND METHODS

The study was performed in 5 embryos aged 8 weeks (developmental stage 23) and 7 foetuses aged 9 weeks. The crown-rump length of the foetuses was between 35 and 48 mm. All embryos and foetuses were sectioned serially in the horizontal, frontal, and sagittal planes and stained according to various methods (Mallory, H+E, and silver salts).

RESULTS

In embryos at stage 23 (8 weeks) the cortical plate was well marked on the dorsolateral and basal surfaces of the cerebral hemisphere (Fig. 1). It was thickest in the insular region, which is an indented area. In the thickest area the plate consisted of 8 to 10 rows of densely packed cells and their processes (Fig. 2). The wall of the cerebral hemisphere had distinct layers, the thickest being the intermediate layer (Fig. 3).

In foetuses at 9 weeks the cortical plate covered the whole surface of the neopallium. It was thickest in the area of the insula (Fig. 4, 5). The cortical plate was composed of 8–12 rows of cells which formed columns arranged perpendicularly to the surface of the hemisphere.

The lamination of the hemispheric wall was the same as in embryos of stage 23 (Fig. 6). The ventricular and subventricular zones were of different thicknesses. The ventricular zone on the cross-section was wider. The subventricular zone contained oval groups of cells. The subplate was irregular in thickness with loosely packed cells (Fig. 5).

DISCUSSION

Corticogenesis refers to the formation of the cortical plate, which forms the primordium of the neocortex [5]. It is evident from the study performed that the cortical plate in foetuses of 9 weeks extends over the whole cerebral surface.

Zecevic et al. [10] showed that in 9-week-old foetuses isolated cells in the deepest region of the cortical plate are weakly immunoreactive for calretinin.

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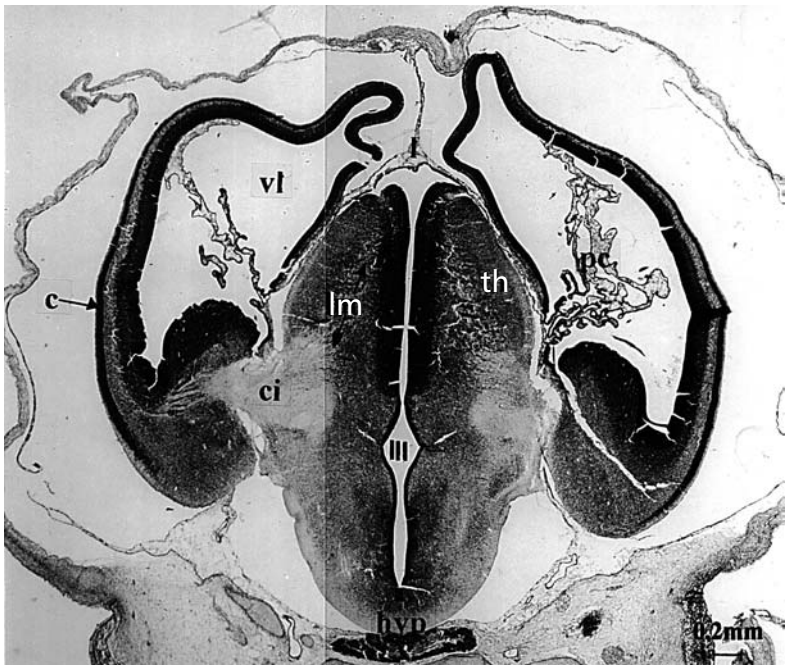

Figure 1. Frontal section of the brain in an embryo at stage 23. H+E. l — lamina terminalis, th — thalamus, pc — choroid plexus, hyp — hypophysis, ci — internal capsule, lm — medullary lamina of the thalamus, vl — lateral ventricle, III — 3rd ventricle.

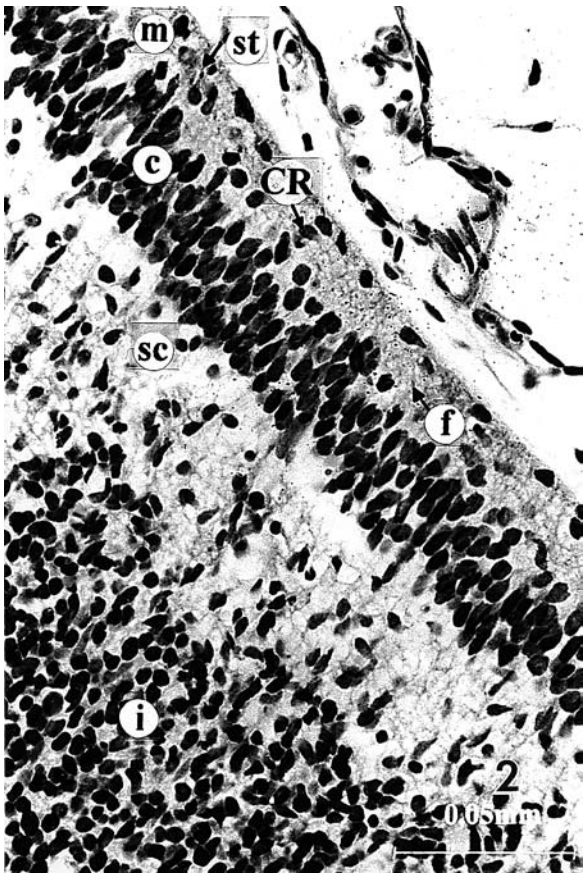

Figure 2. Transverse section of the brain wall in a foetus at stage 23. Impregnation with silver according to the Ogawa method. CR — Cajal-Retzius cells, st — stellate cells, f — nerve fibres, m — marginal layer, c — cortical plate, sc — subplate, i — intermediate layer.

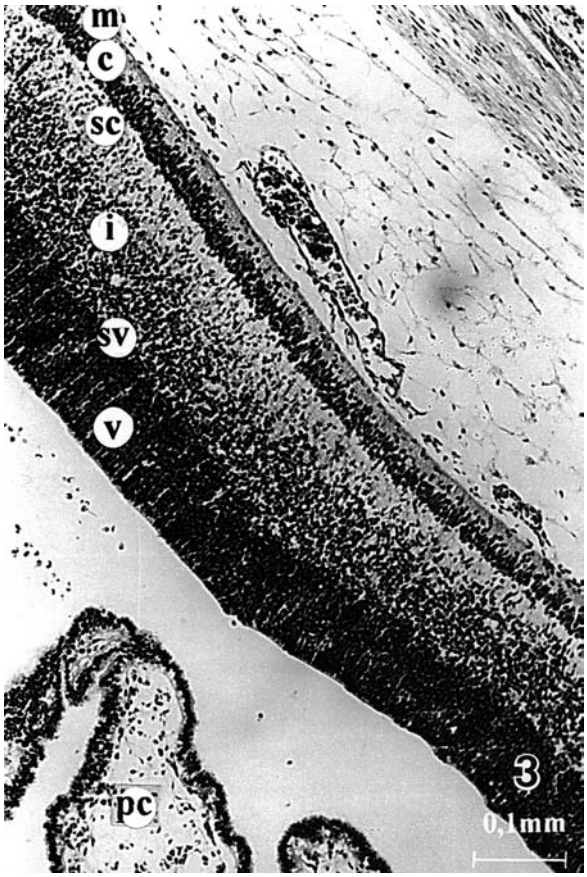

Figure 3. Transverse section of the brain wall in a foetus at stage 23. Impregnation with silver according to the Ogawa method. m — marginal layer, c — cortical plate, sc — subplate, i — intermediate layer, su — subventricular layer, v — ventricular layer, pc — choroid plexus.

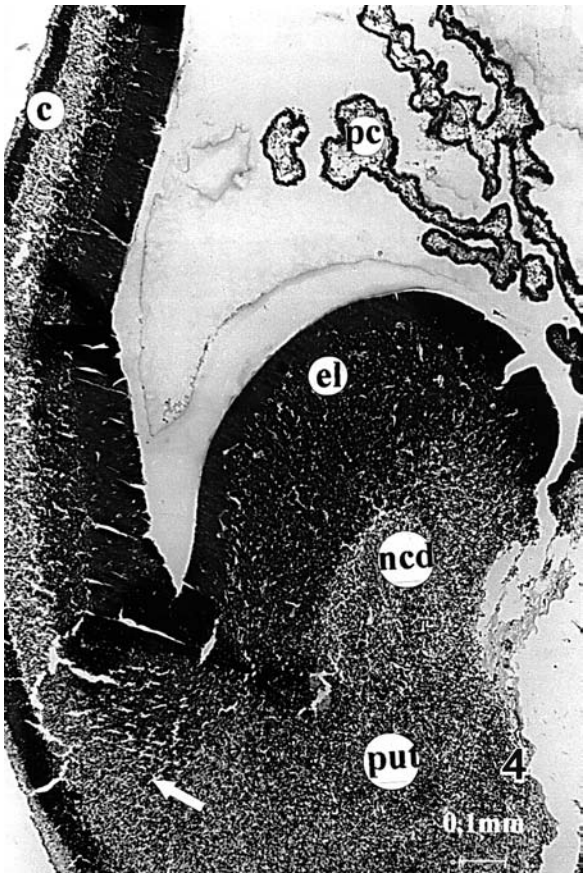

Figure 4. Transverse section of the brain in a foetus aged 9 weeks. Toluidine blue according to Nissl's method. c — cortical plate, pc — choroid plexus, ncd — caudate nucleus, put — putamen, → tangential migration, el — lateral eminence.

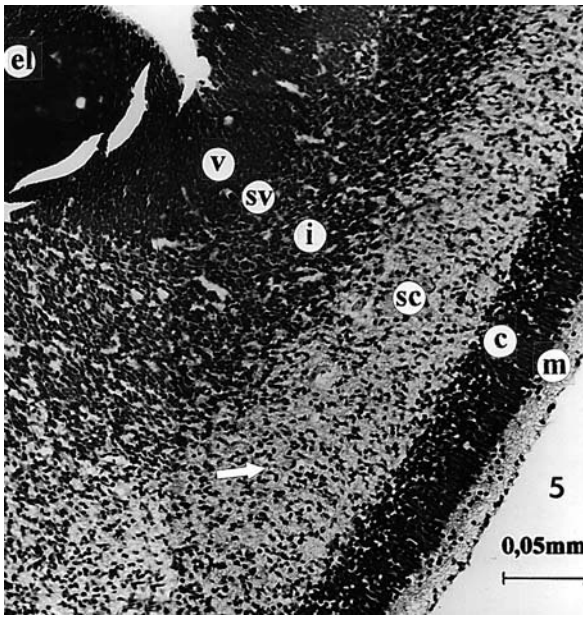

Figure 5. Transverse section of the cerebral wall in a foetus aged 9 weeks. Toluidine blue according to Nissl's method. m — marginal layer, c — cortical plate, sc — subplate, i — intermediate layer, sv — subventricular layer, v — ventricular layer, el — lateral eminence, → tangential migration.

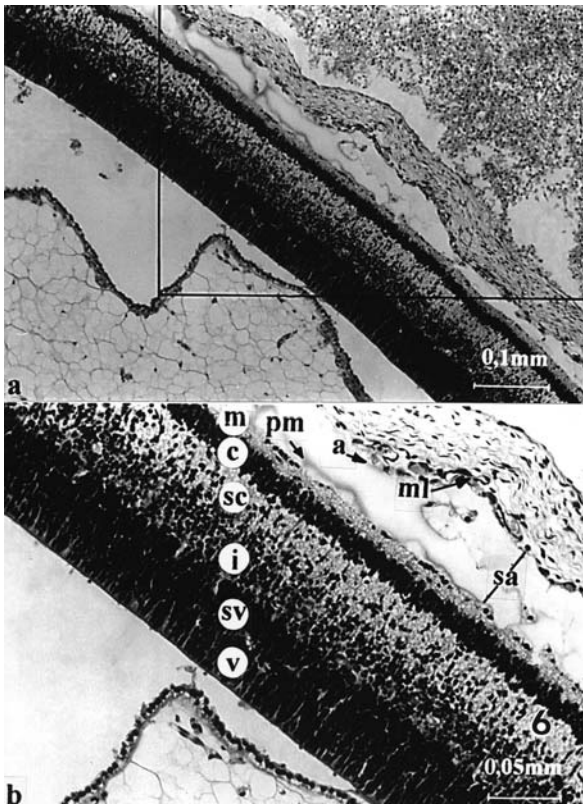

Figure 6. Sagittal section of the cerebral wall in a foetus aged 9 weeks. Toluidine blue according to Nissl s method. ml — lamina limitans of dura, a — arachnoid, sa — subarachnoid space, pm — pia mater, m — marginal layer, c — cortical plate, sc — subplate, i — intermediate layer, sv — subventricular layer, v — ventricular layer.

The morphology of these labelled cells resembles that of developing pyramidal neurons with apical dendrites oriented toward the pia. Uylings et al. [9] also noted immunocytochemical differentiation of cortical neurons in the early foetal period. This is accompanied by proliferation and apoptosis [2].

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